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Team 7: Applying Automated Red Teaming in a Maritime Scenario

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TEAM 7 MEMBERS

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INTRODUCTION

With shipping at the heart of the global economy, maritime security is required to ensure freedom of the seas and to facilitate freedom of navigation and commerce. It is therefore important for nations to stand united and share in the responsibility for maintaining maritime security, when faced with an array of threats from the terrorists and criminals. This study will focus on one aspect of the maritime security - key installation (KINs) protection.

AIM

This study aims to:

- Explore and determine the worst-case scenarios for Blue through Manual Red Teaming (MRT) and Automated Red Teaming (ART)[1];
- Evaluate the usefulness of MRT and ART in Blue Ops Planning.

DESCRIPTION OF SCENARIO

Initial Scenario Set-up. In this baseline scenario, the Blue forces conducted coastal patrols to guard against threats on key installations (KINs). Each of these KINs was represented as a Coastal Surveillance Radar (CSR) equipped with minimum level of self-protection. The Red forces will attempt to penetrate the Blue defense and inflict damages on the Homeland, using various approaches. Any damages to the coastline will dealt a severe psychological blow to the Blue defense force. The initial set-up of experiment was as shown in Figure 1 below.

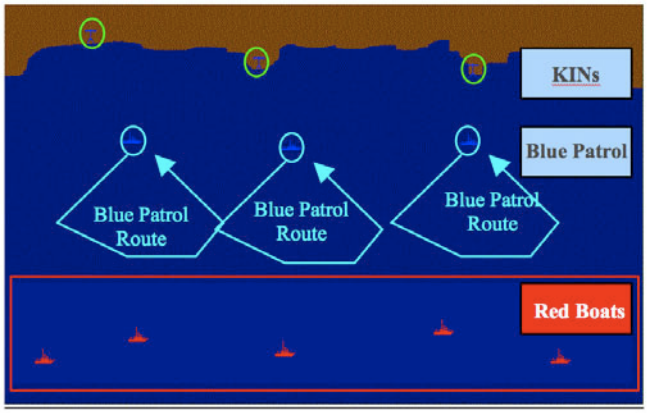

Figure 1: Initial Set-up of Experiment

KEY ASSUMPTIONS

The following key assumptions were made for this scenario:

Area of Operations (AO). The AO was assumed to be in coastal waters away from the sea lines of communications (SLOC) and main shipping traffic. As such, the neutral shipping was not modeled.

Environmental Conditions. It was assumed that the operations were conducted in dark hours with clear weather conditions (i.e. no rain and no moonlight) and calm sea state.

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1 ART was developed by DSO-ORL to find an optimal solution for the Red team (the worst-case scenario for Blue team) in a two-sided scenario, using evolutionary algorithms.

Communication Links. The Blue force was assumed to have full communication link. As for the Red force, it was assumed that the individual boats were operating in accordance to mission plans without any communication links.

KEY MODELING PARAMETERS

Blue Forces. The Blue forces consisted of three KINs and three patrol vessels (PVs). The following modeling parameters were assumed.

- KINs Self-protection. Each KINs were assumed to have a detection range of 5 nm and protected by General Purpose Machine Guns (GPMGs) with the following specifications.

CSR Detection Range (nm)	5
Weapon Range (km)	2
Weapon Single Shot Probability of Hit (SSHP)	0.1

Table 1: Specifications of KINs Self-protection

- Patrol Vessels. Each PVs was assumed to conduct normal patrol at 15 knots and give chase at a maximum speed of 25 knots. The PVs were also assumed to be capable of neutralizing the Red boats by closing in within 0.5 nm and maintaining this distance for 1 min. The dynamics of the close water combat was not modeled. In addition, the PVs would be activated to investigate detections made by the CSRs so as to achieve target identification and neutralization. A summary of the key specifications of the Blue PVs was as follows:

PV Speed [Patrol] (knots)	15
PV Speed [Chase] (knots)	25
PV Detection Range (nm)	3
PV Identification (ID) Range (nm)	1

Table 2: Specifications of Blue PVs

Red Forces. Five Red boats were modeled as small fishing boats with a maximum speed of 25 knots and loaded with explosives. These boats were assumed to be without any onboard sensors and have a visual detection and identification range of 1 nm.

Maximum Speed (knots)	25
Detection/ID Range (nm)	1

Table 3: Specifications of Red Boats

MEASURE OF EFFECTIVENESS

The MOEs were:

- Number of Successful Red attacks on KINs/ Coastline
- Red Attrition

METHODOLOGY

Refinement of Blue Plan

The team members were asked to refine the Blue patrol plan as the baseline scenario may not be adequate to present a strong case for surprises to develop during the MRT and ART phase. After several rounds of deliberations and trials, the team decided on deploying a Blue standby PV (goalkeeper) in the vicinity of one of the KINs while the other two PVs were deployed as forward patrol within the detection range of the KINs. A broad deployment concept for the improved Blue patrol plan is as shown in Figure 2 below.

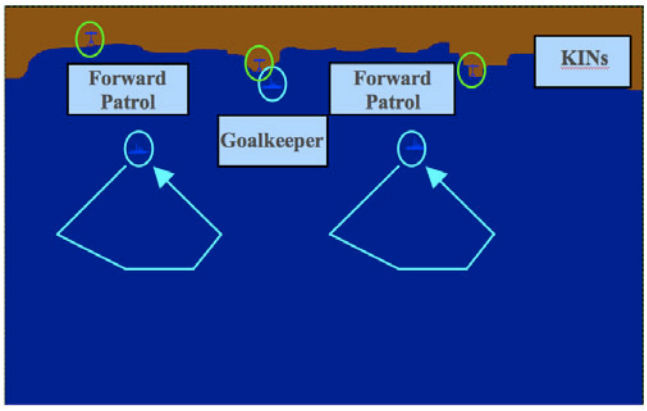

Figure 2: Refined Blue Patrol Plan

Manual Red Teaming

After the Blue patrol plan had been refined, the team then went on to develop the Red attack plan through MRT effort. Two Red plans were developed as a results based on different tactics and deployment concept.

Flanking Tactics. Firstly, the team noted that the Blue forces were concentrated in the middle and decided to deploy the Red forces into two different groups to approach the targets on the flanks. A schematic of the deployment plan is as presented in Figure 3 below.

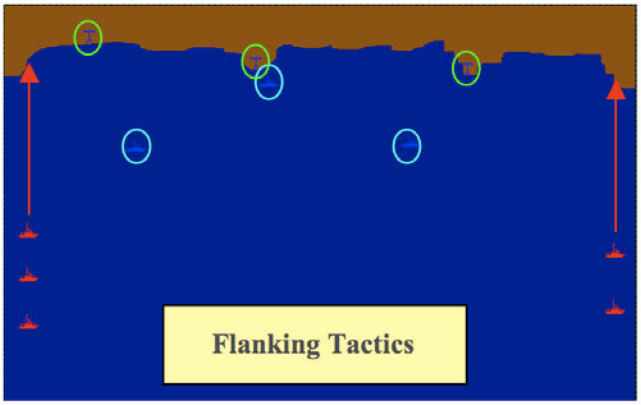

Figure 3: Flanking Tactics

Decoy Tactics. Next, the team then went on to develop the second Red tactic that was as effective as the first one (achieve 100% Red mission success) but not exactly as efficient (higher Red attrition). The second concept involved a group of three Red boats approaching from a central route to provide decoy for the other two Red boats on the sides to dash for the targets. A diagram on the deployment plan is as shown below in Figure 4.

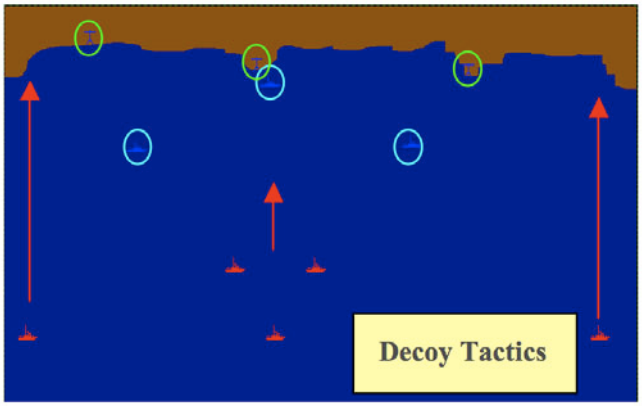

Figure 4: Decoy Tactics

Automated Red Teaming

Formulation of Red Tactics through ART. Subsequently the team used the ART framework to develop two Red tactics[2] (ART Tactic 1 and ART Tactic 2) for comparison against the MRT efforts, through the evolution of the following parameters.

- Individual Red Boat Starting Positions
- Individual Way-point Positions
- Aggressiveness (Propensity towards Enemy)
- Cohesiveness (Propensity towards Uninjured Friends)
- Determination (Propensity towards Waypoint)

Decoy and Flanking Tactics complemented with ART. Both the Decoy tactic and Flanking tactic developed through MRT effort were further red-teamed through the ART framework by evolving the following intangibles parameters:

- Aggressiveness
- Cohesiveness
- Determination

RESULTS AND ANALYSIS

ART Tactics 1

Concept of Decoy. It was interesting to note that the ART framework produced a surprising variation of decoy concepts. Under the plan, one of the Red boats from left was deployed to draw the Blue PV on the left towards the right side to create an opening for the other two Red boats to charge towards their objectives. This deployment was counter-intuitive as most of the team members had initially written it off, thinking that longer exposure would lead to lower survivability and hence lower mission success.

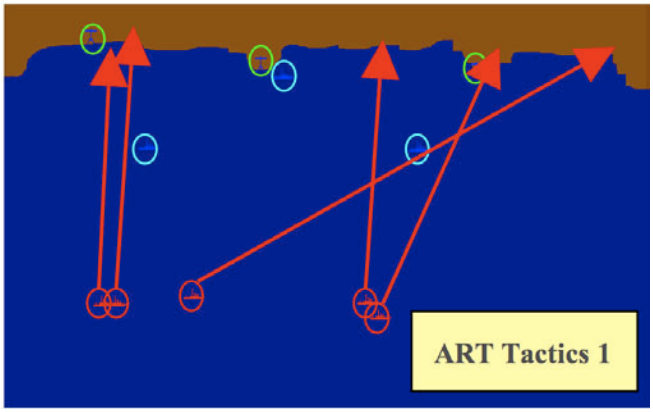

Figure 5: ART Tactics 1

ART Tactics 2

Saturation Tactic. In ART tactics 2, a mix of saturation and decoy deployment concepts were applied to achieve the optimal tactic. Nonetheless, it is apparent that saturation contributed more to the Red mission success. The group of four Red boats on the left was

2 ART Tactic 1 was developed during IDFW 14 while ART Tactic 2 was a post-workshop run for robustness of results.

deployed to saturate the Blue forces. The eventual engagements would then allow those remaining Red survivals to slip through and achieve mission objectives, as shown in Figure 6 below.

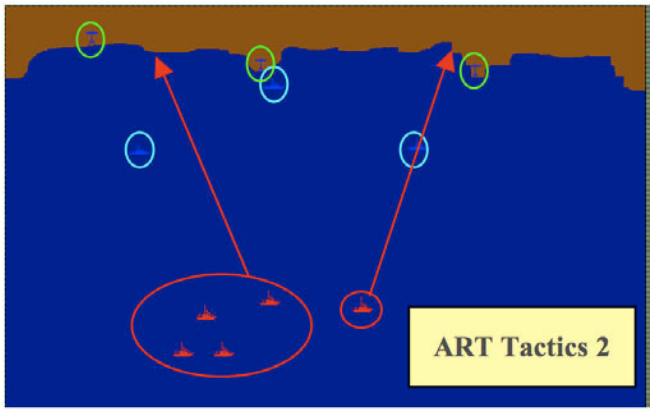

Figure 6: ART Tactics 2

MRT complemented with ART

From the results below in Table 4, it was evident that there was marked improvement in the Red mission success and Red attrition after evolving the intangibles using the ART framework. All the plans through the MRT and ART efforts produced a 100% red mission success but shown varied levels of improvement for the Red attrition. The best plan was the flanking tactics which produced an improvement of 86.7% to a mere 0.41 Red attrition.

	Base	Flanking		Decoy		ART Tactics 1	ART Tactics 2
		Orig.	ART	Orig.	ART		
Aggressiveness	-60	-60	-76	-60	-30	-83	-74
Cohesiveness	-100	-100	16	-100	60	8	26
Determination	60	60	86	60	73	53	80
Red Mission Success	47%	100%	100%	100%	100%	100%	100%
Red Attrition	2.51	0.85	0.41	3.05	1.69	1.89	0.95
% Improvement (Red Mission Success)	N.A.	113%	113%	113%	113%	113%	113%
% Improvement (Red Attrition)	N.A.	66.1%	86.7%	21.5%	32.7%	24.7%	62.2%

Table 4: ART Run Results

SUMMARY OF FINDINGS

Through the exercise during IDFW 14, two broad observations were made.

MRT complemented with ART. Firstly, the team managed to show that through the evolution of intangible parameters, ART was able to enhance the Red performance from their MRT tactics. Therefore it reinforced the belief that MRT efforts can be further enhanced using the ART framework.

Surprises from ART. Secondly, it was interesting to note that the ART had produced plans that has incooperated similar decoy tactics, as in the manual decoy tactics, and offered an alternative approach that has been written off initially.

CONCLUSIONS

This study has discussed some of the strengths and weaknesses of the ART framework. Despite its limitations, ART framework had proven its worth and is highly recommended to be used to complement MRT efforts during the ops planning phase.

LOOKING AHEAD

The next phase for the ART project is to embark on the Automated Co-Evolution (ACE). ACE will be looking at Blue Teaming vs Red Teaming in typical 2-sided scenarios, using evolutionary algorithms.